B. Sc. (Honours) in Mathematics

Under the Framework of Honours School System

Semester I - VI

PANJAB UNIVERSITY, CHANDIGARH

OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR

CHOICE BASED CREDIT SYSTEM B.Sc. (HONOURS) MATHEMATICS UNDER THE FRAMEWORK OF HONOURS SCHOOL SYSTEM

(SEMESTER SYSTEM) EXAMINATION, 2020-2021

OUTLINES OF TESTS

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Mathematics and their applications. The syllabus pertaining to B.Sc. (Honours) Mathematics (3 Year course & 6 Semesters) in the subject of Mathematics under Honours School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. Honours (Mathematics).

Semester I

CORE COURSE (MATHEMATICS)

Theory Papers:

Core Course-1 (MAT -C1):	Calculus	100 Marks (4 credits)
Core Course-2 (MAT-C2):	Algebra	150 Marks (6 credits)

Practical:

Core Course-1 Practical (MAT-C1):	Calculus	50 Marks (2 credits)

GENERIC ELECTIVE (MATHEMATICS)

Each student from other disciplines may opt any two of the generic electives offered by the Science Departments of Panjab University out of following:

GENERIC ELECTIVE SUBJECTS (Offered by Mathematics Department) *for students of departments of* Bio-Medical Sciences

Semester-I

1. MAT-GE1-BM: Algebra and Geometry 150 Marks (6 Credits)

GENERIC ELECTIVE SUBJECTS (Offered by Mathematics Department) *for students of departments of* Physical Sciences

Semester-I

1. MAT-GE1-PS: Advanced Calculus and Geometry 150 Marks (6 Credits)

EVALUATION

1. There shall be one Mid Term Examination of 20% Marks in each semester.
2. End-semester examination will be of 80% of total marks.
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks.
5. The final examination will be of 80% marks

Pattern of end-semester question paper

(i) Nine questions in all with equal weightage. The candidate will be asked to attempt five questions

(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.

(iii)The remaining eight questions will have **Four Units** comprising two questions from each Unit.

(iv) Students will attempt one question from each unit and the compulsory question.

ABILITY ENHANCEMENT COMPULSORY COURSE FOR MATHEMATICS STUDENTS

Each student of Mathematics Department has to opt one Ability Enhancement Compulsory Course of the following:

1. English Communication (2 credits)
2. Environmental Science (2 credits)

PREAMBLE

To teach the fundamental concepts of Mathematics and their applications. The syllabus pertaining to B.Sc. (Honours) Mathematics (3 Year course & 6 Semesters) in the subject of Mathematics under Honours School framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. (Honours School) Mathematics.

COURSE STRUCTURE

SEMESTER I		SEMESTER II	
C1	**MAT-C1: Calculus**	**C3**	**MAT-C3: Real Analysis**
C2	**MAT-C2: Algebra**	**C4**	**MAT-C4: Differential Equations**
AECC1	**MAT-AECC1: English/ MIL Communications/ Environment Science**	**AECC2**	**MAT-AECC2: English/ MIL Communications/ Environment Science**
GE1*	**MAT-GE1** **MAT- GE2**	**GE2***	**MAT-GE3** **MAT-GE 4**

SEMESTER III		SEMESTER IV	
C5	**MAT-C5: Theory of Real Functions**	**C8**	**MAT-C8: Numerical Methods**
C6	**MAT-C6: Group Theory I**	**C9**	**MAT-C9: Riemann Integration and series of Functions**
C7	**MAT-C7: PDE and system of ODE**	**C10**	**MAT-C10: Ring Theory and Linear Algebra I**
SEC1		**SEC2**	
GE3*	**MAT-GE5**	**GE4***	**MAT-GE6**

SEMESTER V		SEMESTER VI	
C11	**MAT-C11: Multivariate Calculus**	**C13**	**MAT-C13: Metric Spaces and complex Analysis**
C12	**MAT-C12: Group Theory II**	**C14**	**MAT-C14: Ring Theory and Linear Algebra II**
DSE1	Number Theory	**DSE2**	Probability and statistics
DSE3	Discrete Mathematics	**DSE6**	Dynamics
DSE4	Statics	DSE8	Mathematical Modeling

C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective

***: GE subjects are to be selected by the students from the pool of GE Subjects offered by various Departments of the University.**

****SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)**

1. MAT-SEC1: Logic and Sets
2. MAT-SEC2: LaTex and HTML
3. MAT-SEC3: Graph Theory
4. MAT-SEC4: Computer Algebra systems and Related Software

****DISCIPLINE SPECIFIC ELECTIVE COURSES (any two per semester in semesters 5-6)**

1. MAT-DSE1: Number Theory
2. MAT-DSE2: Probability and Statistics
3. MAT-DSE3: Discrete Mathematics
4. MAT-DSE4: Statics
5. MAT-DSE5: Linear Programming
6. MAT-DSE6: Dynamics
7. MAT-DSE7: Differential Geometry
8. MAT-DSE8 : Mathematical Modeling

**Courses under these will be offered only if a minimum of 10 students opt for the same

***GENERIC ELECTIVE SUBJECTS (any two per semester in semesters I-II and one per semester in Semester III-IV)**

The Core courses MAT- C1, MAT- C2, MAT-C-3 and MAT-C4 of semester I-II may be the generic elective subjects of other departments.

GENERIC ELECTIVE SUBJECTS (Offered by Mathematics Department) *for students of departments of* Bio-Medical Sciences

Semester-I

1. MAT-GE1-BM: Algebra and Geometry
2. MAT-GE2-BM: Algebra and Geometry

Semester-II

1. MAT-GE3-BM: Calculus
2. MAT-GE4-BM: Calculus

Semester-III

1. MAT-GE5-BM: Matrices

Semester-IV

1. MAT-GE6-BM: Vector Analysis, Differential Equations and Transform

GENERIC ELECTIVE SUBJECTS (Offered by Mathematics Department) *for students of departments of* Physical Sciences

Semester-I

1. MAT-GE1-PS: Advanced Calculus and Geometry
2. MAT-GE2-PS: Advanced Calculus and Geometry

Semester-II

1. MAT-GE3-PS: Linear Algebra
2. MAT-GE4-PS: Linear Algebra

Semester-III

1. MAT-GE5-PS: Differential Equations and Fourier Series

Semester-IV

1. MAT-GE6-PS: Integral Transforms and complex Analysis

***Each of Core, Generic Elective and Discpline Specific Elective subjects consists of 60 lectures, which consists of (i) 48 contact hours of teaching to be delivered exclusively by the teacher as per the scheduled time-table and (ii) 12 hours for the interaction, discussion, assignments and seminars (attended/delivered) by the students.**

Semester I

MAT-C1: Calculus

THEORY

4 hrs.per week
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 40 **Credits: 4**

Objective: The main goal of this course is to deliver the basics of differential and integral calculus, for real as well as multivariate functions. It is expected that the students develop a taste of writing proofs, particularly for Unit I, rather than applying formulas only.

Unit I

Differential Calculus

Precise definition of limit, continuity, one-sided limit, limits involving infinity, asymptotes of graphs, tangents and the derivative at a point, the derivative of a function, extreme values of functions, mean value theorem, monotone functions and the first derivative test, test for concavity, tracing of curves.

(Scope: Sections 2.3 – 2.6, 3.1, 3.2, 4.1 –4.4 of [1]).

Unit II

Integral Calculus

Riemann sums, definite integrals, area between curves, volumes using cross sections and cylindrical shells, arc length and areas of surfaces of revolution.

(Scope: Sections 5.1, 5.6, 6.1 – 6.4 of [1]).

Unit III

Multivariable Functions

Limits and continuity for functions of several variables, partial derivatives, the chain rule, directional derivatives, gradient vectors, tangent planes, extreme values and saddle points, Lagrange multipliers.

(Scope: Sections 14.2 – 14.8 of [1].).

Unit IV

Multiple Integrals

Double integrals, triple integrals, Jacobian, substitutions in multiple integrals, Green's theorem, Stoke's theorem and the divergence's theorem.

(Scope: Relevant sections of Chapters 15, 16 of [1]).

List of Practicals (using any software)

(i) Matrix operations (addition, multiplication, inverse, transpose, determinant and rank).
(ii) Plotting of graphs of polynomials of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
(iii) Plotting functions $e^{ax} + b$, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax + b), |ax + b|and to illustrate the effect of a and b on the graph.
(iv) Obtaining surfaces of revolution of curves.
(v) Tracing of conics in Cartesian coordinates/ polar coordinates.
(vi) 3D plots.
(vii) Computation of limits, derivatives and integration of vector functions.
(viii) Tangent planes to surfaces at a given point.
(ix) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using Cartesian coordinates.

Books Recommended

1. George B. Thomas, Maurice D. Weir and Joel R. Hass, *Thomas'Calculus*, 12th Ed., Pearson Education, New Delhi, 2014.
2. Joseph L. Taylor, Foundationsof Analysis, Pure and Applied Undergraduate Texts, 18, ***American Mathematical Society, Providence, RI,*** 2012.
3. Shanti Narayan, *Integral Calculus*, S. Chand and Company Ltd, 2001.
4. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
5. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
6. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

MAT-C1: Calculus

PRACTICAL

(Using any software)

(3 practicals per week)
In groups of 15 students
[Max. Marks: 50](Final-40+Internal Assessment-10)
Time : 3hrs.

Total Lectures : 20 **Credits: 2**

List of Practicals (using any software)

(i) Plotting of graphs of function eax + b, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax + b), |ax + b|and to illustrate the effect of a and b on the graph.

(ii) Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.

(iii) Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).

(iv) Obtaining surface of revolution of curves.

(v) Tracing of conics in Cartesian coordinates/ polar coordinates.

(vi) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using cartesian coordinates.

(vii) Matrix operation (addition, multiplication, inverse, transpose).

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.

3. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.

4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

MAT-C2: Algebra

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

2. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.

3. There will be two questions from each unit and the students will be required to answer one question from each unit.

4. All questions carry equal marks.

Total Lectures : 60 **Credits: 6**

Objective : The concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences. The emphasis will be to combine the abstract concepts with examples in order to intensify the understanding of the subject.

UNIT I (15 hrs)

Review of system of linear equations, general theory of system of linear equations, n-dimensional vector space, linear dependence, rank of a matrix, system of homogenous and non- homogeneous linear equations, an axiomatic construction of theory of determinants.
(Scope as in chapters 1, 2, 3 of [1])

UNIT II (15 hrs)

A deeper look at Complex Numbers, taking roots of complex numbers, quick review of operations on polynomials, divisors and greatest common divisor, roots of polynomials, fundamental theorem, corollaries of fundamental theorem, rational fractions.
(Scope as in chapters 4 and 5 of [1])

UNIT III (15 hrs)

Evaluating roots of polynomials of third and fourth degree, bounds of roots, sturm's theorem, other theorems on the number of real roots, approximation of roots.
(Scope as in chapter 9 of [1])

UNIT IV (15 hrs)

Definition of a linear space , an isomorphism, finite dimensional spaces, bases, linear transformation linear subspaces, characteristic roots and eigen values, (Scope as in chapter 2 of [6])

References:

1. A. Kurosh, Higher Algebra, MIR Moscow, 1982
2. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian reprint, 2007.
3. S.H. Friedberg, A.J. Insel and L.E. Spence: Linear Algebra, Prentice Hall, 2003.
4. K. Hoffman and R. Kunze: Linear Algebra, 2nd Edition, Prentice-Hall of India, 1989.
5. S. Lang: Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989.
6. Vivek Sahai and Vikas Bist, *Linear Algebra*, 2nd Ed., Narosa Publishing house 2013.
7. P. Lax, Linear Algebra, John Wiley & Sons, New York. Indian Ed. 1997.
8. P. B. Bhattacharya, S.K. Jain and S. R. Nagpaul, *First Course in Linear Algebra,* Wiley Eastern Limited.

Semester II

MAT-C3: Real Analysis

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: Introduction to the cardinality of sets, completeness property of real numbers, sequences and series of real numbers and the limit and continuity of real functions.

Unit I

Finite and infinite sets, countable and uncountable sets, Cantor's theorem, Schroder-Bernstein theorem, the Cantor set, the completeness property of reals, applications of the supremum property, the Archimedean property, density of rational numbers in reals, intervals, decimal and general expansions of reals.

(Scope: Sections 1.3, 2.3, 2.4, 2.5 of [1] and pages 24-29 of [2].)

Unit II

Sequence and their limits, limits theorems, monotone sequences, subsequences and the Bolzano-Weierstrass theorem, monotone subsequence theorem, the Cauchy criterion, the Cantor nested interval theorem, divergence of a sequence.

(Scope: Sections 3.1 to 3.6 of [1].)

Unit III

Limit of a function (epsilon-delta approach) andlimit theorems, continuous functions, combinations of continuous functions, extensions of the limit concept, continuous functions on intervals, monotone functions and inverse functions.

(Scope: Sections 4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 5.6 of [1].)

Unit IV

Introduction to infinite series, absolute convergence of infinite series, tests for absolute convergence, tests for non-absolute convergence of a series.

(Scope: Sections 3.7, 9.1, 9.2, 9.3 of [1].)

Books Recommended

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. N. L. Carothers, *Real Analysis*, Cambridge University Press 2000.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall, 2001.
4. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, 2nd Ed., Jones & Bartlett, 2010.
5. T. M. Apostol, *Mathematical Analysis*, 2nd Edition, Narosa Publishing House, Reprint 2002.
6. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.
7. S.K. Berberian, *Fundamentals of Real Analysis,* Springer Verlag, New York, 1998.
8. M. H. Protter and C. B. Morrey, *A First Course in Real Analysis,* 2nd Edition, Springer Verlag, Indian Reprint, 2004.
9. C. C. Pugh, *Real Mathematical Analysis,* Springer Verlag, New York, 2001.
10. S. Abbott, Understanding Analysis, Springer Verlag, New York, 2008.

MAT-C4: Differential Equations

THEORY

[4 hrs/per week]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 40 **Credits: 4**

Objective: *To exhibit the techniques for obtaining solutions to ordinary differential equations and the basic ideas and theory behind those techniques.*

UNIT I (10 hrs)

Classification of Differential Equations: Their Origin and applications. Nature and method of solutions. Initial and boundary value problem. Existence and uniqueness theorem. (Scope as in Chapter 1 of Ref. [3]).

Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations. Clairaut equation. (Scope as in Chapter 2 of Ref. [3])

UNIT II (10 hrs)

Applications of First Order Equations: Orthogonal and oblique trajectories. (Scope as in Chapter 3 of Ref. [3]), Higher-Order Linear Differential Equations: Basic Existence Theorem, The Homogeneous Equation, Wronskian, its properties and applications.

Reduction of order, then on-homogeneous equation, the homogeneous linear equation with constant coefficients, initial-value problem, the Cauchy-Euler equation, theorems on the second-order homogeneous linear equation. (Scope as in Chapter 4 of Ref. [3])

UNIT III (10 hrs)

The method of undetermined coefficients, method of variation of parameters, basic properties of the Laplace transform, the inverse Laplace transform, Solving IVP's with Laplace transforms.

UNIT IV (10 hrs)

Ordinary points and singular points, power series solution about an ordinary point, power series solution about singular points, The method of Frobenius.
(Scope as in Chapter 6 of Ref. [3]).

References:

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab,* 2ndEd., Taylor and Francis group, London and New York, 2009.
2. C.H. Edwards and D.E. Penny, *Differential Equations and BoundaryValue problems Computing and Modeling,* Pearson Education India, 2005.
3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L Abell, Jame sP Braselton, *Differential Equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.
5. E. A. Coddington, An introduction to ordinary differential equation, Prentice- Hall of India.
6. W. E. Boyce and R. C. Diprima, Elementary differential equations and boundary value problems.
7. Earl D. Rainville and P. E. Benediet, Elementary differential equations, Seventh edition, Macmillian, Publishing Company, 1989.

MAT-C4: Differential Equations
PRACTICAL

(3 practicals per week)
In groups of 15 students
[Max. Marks: 50](Final-40+Internal Assessment-10)
Time : 3hrs.

Total Lectures: 20 **Credits: 2**

List of Practicals (using any software)

1. Plotting and finding solution of first order differential equation.
2. Plotting and finding solution of second order differential equation.
3. Plotting and finding solution of third order differential equation.
4. Solution of initial value problems
5. Solution of boundary value problem.
6. Exponential growth model.
7. Exponential decay model.
8. Limited growth of population
9. Orthogonal and Oblique Trajectories
10. Solution of ODE by Reduction of order.
11. Power series solution and matching with exact solution.

References:

1. Belinda Barnes and Glenn R. Fulford, Mathematical *Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab,* 2nd Ed., Taylor and Francis group, London and New York, 2009.
2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problems Computing and Modeling,* Pearson Education India, 2005.
3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.
5. E. A. Coddington, An introduction to ordinary differential equation, Prentice- Hall of India.
6. W. E. Boyce and R. C. Diprima, Elementary differential equations and boundary value problems.
7. Earl D. Rainville and P. E. Benediet, Elementary differential equations, Seventh edition, Macmillian, Publishing Company, 1989.

GENERIC ELECTIVE SUBJECTS

GE1 COURSES

MAT-GE1-BM: Algebra and Geometry

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150](Final-120+Internal Assessment-30)
Time : 3hrs.

Note **: 1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

Total Lectures: 60 **Credits: 6**

Objective: The objective of this course is to study the basics of various topics of Mathematics which is a foundation for further learning in Mathematics, Physics, Statistics etc.

UNIT I (15 hrs)

Review of trigonometric functions, sum and product formulae for trigonometric functions, Trigonometric Equations.
[Scope as in Chapters 3 of a Textbook – 'Mathematics' for Class XI, NCERT.]

Complex Numbers and Quadratic Equations, Permutations and combinations, Binomial Theorem, sequences and series. Exponential and Logarithmic series.
[Scope as in Chapters 5,7,8, 9, Appendix 1 of a Textbook – 'Mathematics' for Class XI, NCERT.]

UNIT II (15 hrs)

Matrices, Operations on Matrices, Determinants, singular and non-singular matrices, Adjoint and inverse of a matrix [Scope as in Chapters 3 , 4 of a Text book-'Mathematics' for Class XII, NCERT. Part I]

UNIT III (15 hrs)

Co-ordinate Geometry: Rectangular Coordinate system. Straight lines. Circles and family of circles. Parabola, Ellipse and Hyperbola-their equations in standard form.
[Scope as in Chapters 10, 11 of a Textbook- 'Mathematics' for Class XI, NCERT.]

UNIT IV (15 hrs)

Three dimensional space, Coordinates of a point in three dimensional space. Distance between two points. Section Formula [Scope as in Chapter 12 of a Text book – 'Mathematics' for Class XI, NCERT.]

Suggested Readings

1. Mathematics, A Text book for Class XI and XII, NCERT, 2003 New Delhi.
2. Thomas Calculus, 12th Edition, Pearson, 2014.

MAT-GE1-PS: Advanced Calculus and Geometry

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150](Final-120+Internal Assessment-30)
Time : 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: The objective of the course is to equip the students with the knowledge of basic concepts and their applications in geometry.

UNIT I (15 hrs)

Vector-valued function and space curves. Arc length and unit tangent vector. Limit and continuity of multivariable function. Partial derivatives. Directional derivatives, gradiant vectors and tangent planes, Double integrals. Fubini's Theorem without proof, Change of order of integration in double integrals, double integrals in polar form (Chapters 11 Secs. 11.1, 11.3, Chapter 12.1-12.3, 12.7 and 13.1-13.3 of 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9^{th} Edition.

UNIT II (15 hrs)

Triple integrals in rectangular, spherical and cylindrical coordinates, substitution in multiple integrals. [Scope as in Sections 13.4, 13.6, 13.7 of Chapter 13 in the book 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9^{th} Edition.]

Line integrals vector fields. Path independence and surface integrals. Divergence and Stoke's theorem (Applications only). [Scope as in Sections 14.1, 14.3, 14.4, 14.5, 14.7 of Chapter 14 of the book 'Calculus and Analytic Geometry' by G. B. Thomas and R. L. Finney, 9^{th} Edition.]

UNIT III (15 hrs)

Transformation of axes, shifting of origin, reflection and rotation of axes, reduction of the equation $S=Ax^2+Bxy+Cy^2 +Dx+Ey+f=O$ into simpler forms by transformation of coordinate axes(without proof). Identification of curves represented by S=0. Invariance of discriminant and trace t. Condition that a second degree equation should represent a pair of straight lines. Polar coordinates, polar equation of a conic.

[Scope as in Chapters 1, 6(Sections 6.1-6.4), 7(Sections 7.1-7.8, 7.11-7.15) from Plane Geometry of "New Pattern Vector Algebra and Geometry" by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

UNIT IV (15 hrs)

Sphere, Cone, Cylinder, Equation of paraboloid, ellipsoid and hyperboloid in standard forms. Simple properties of these surfaces. Equation of tangent planes to the above surfaces.

[Scope as in Chapters 1(Sections 1.1-1.6, 1.11-1.14), 2(Sections 2.1-2.5, 2.12, 2.13), 3(Sections 3.1-3.3), 4(Sections 4.6, 4.7, 4.10, 4.11) from Solid Geometry of "New Pattern Vector Algebra and Geometry" by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

Suggested Readings

1. Thomas Calculus, 12th Edition, Pearson, 2014.
2. Shanti Narayan: Analytic Geometry.
3. J. P. Mohindru, Mrs. Usha Gupta & A. S. Dogra : New Pattern Vector Algebra and Geometry, International Publishers, New Edition(2004).
4. Schaum's Outlines, Vector Analysis, Tata McGraw-Hill Publishers, 2nd Edition.
5. Calculus and Analytical Geometry by G. B. Thomas and R. L. Finney, 9th Edition.

SEMESTER-II

MAT-GE3-BM: Calculus

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150](Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: This course is designed to introduce the fundamental concepts of continuity, differentiation and integration of functions of one variable. Its objective is to acquaint students with various applications of these topics relating to extreme value problems, problems of finding areas and distance travelled, moreover to describe connection between integral and differential calculus through Fundamental Theorem of Calculus.

UNIT I (15 hrs)

Continuity and Differentiability : Introduction. Limits. Continuity. Differentiability. Exponential and Logrithmic Differentiation. Derivative of a function in parameter Second order derivative . Mean Value Theorem [Scope as in Chapter 13 of a text book of Mathematics of XI & Chapter 5 of a text book- Mathematics for class XII Part- I NCERT].

UNIT II (15 hrs)

Application of derivative : increasing and decreasing functions. Maxima and Minima. Rolle's Theorem (without proof). Mean Value Theorem. Tangents and Normals. [Scope as in Chapters 6 of a Text book –'Mathematics' for Class XII, NCERT.]
Indeterminate forms, L'Hopital's Rule. Taylor and Maclaurin series(without proofs). [Scope as in Section 6.6 of Chapter 6 and Section 8.9 & 8.10 of Chapter 8 of a book 'Calculus' by Thomas & Finney, 9^{th} Edition.]

UNIT III (15 hrs)

Integral Calculus: Integral as antiderivative. Integration by substitution, by partial fractions and by parts. Definite integral and its properties. Areas of bounded regions. The definition of integral of a real valued function of real variable as limit of sum

motivated by the determination of area. Fundamental theorem of integral calculus.[Scope as in Chapters 7 &8 of a Text book- 'Mathematics' for Class XII, NCERT. Part II]

UNIT IV (15 hrs)

Differential Equations : Introduction & basic concepts. General and particular solutions of a differential Equation. Formation of differential equation. Metheds of solving First order, First degree Differential equations [Scope as in Ch 9 of a text book-Mathematics for class XII Part II]

Suggested Readings

1. Mathematics, A Text book for Class XI and XII (Parts I & II), NCERT 2003, New Delhi.
2. 'Calculus' by Thomas & Finney, 9th Edition, Pearson Education, 2004.
3. Thomas Calculus, 12th Edition, Pearson, 2014.

MAT –GE3-PS: Linear Algebra

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150](Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: This Course is a requirement for majors in other sciences because Linear Algebra provides a basis for advanced studies not only in Mathematics but also in other branches like engineering, physics and computers etc.

UNIT I (15 hrs)

Vector spaces over R and C, subspaces, linear span of vectors, linear independence and dependence, basis and dimension. Row rank, Column rank and determinantal rank of a matrix. Elementary row and column operations. Elemetary matrices. Row echelon form of a matrix. Equivalence of matrices. Reduction to normal form under equivalence(method only). The equality of three ranks(statement only).

UNIT II (15 hrs)

Methods of solving a system of equations with special reference to Gauss method, Matrix Inversion. Linear transformations. Rank and Nullity of a linear transformation, Inverse of a Linear Transformation. Rank and Nullity Theorem and its consequences. Matrix of a linear transformation with respect to a given basis.
[Scope as in Chapters 3(Sections 3.1-3.6), 4(Sections 4.1-4.5), 5(Sections 5.1, 5.2, 5.7-5.9) of the book 'Introduction to Linear Algebra' by V. Krishnamurthy, V.P.Mainra and J. L. Arora, East-West Press Pvt. Ltd.]

UNIT III (15 hrs)

Cayley-Hamilton Theorem. Characteristic roots and characteristic vectors of a square matrix. Nature of roots of different types of matrices, Minimal polynomial of a matrix.

UNIT IV (15 hrs)

Similarity of matrices, similarity reduction to a diagonal form, diagonalizable matrix, orthogonal reduction of real symmetric matrices. Unitary reduction of a Hermitian

matrix (for these three reductions only the methods are expected to be taught. No proofs are expected to be taught).

[Scope as in 11(Sections 11.1-11.5, 11.11-11.13), 12(Sections 12.1-12.3), 13(Sections 13.1-13.4) of the book 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, 10^{th} edition, S. Chand & Co.]

References

1. V. Krishnamurty, V.P. Mainra and J. L. Arora, Introduction to Linear Algebra, East-West Press Pvt. Ltd. 1976.

2. Shanti Narayan and P. K. Mittal, A textbook of Matrices, S. Chand & Co., 2010.

3. Schaum's Outlines, Linear Algebra, Tata McGraw-Hill Publishers, 3^{rd} edition.

GE2 COURSES

SEMESTER-I

MAT-GE2-BM: Algebra and Geometry

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: The objective of this course is to study the basics of various topics of Mathematics which is a foundation for further learning in Mathematics, Physics, Statistics etc.

UNIT I (15 hrs)

Review of trigonometric functions, sum and product formulae for trigonometric functions, Trigonometric Equations. [Scope as in Chapters 3 of a Textbook – 'Mathematics' for Class XI, NCERT.]

Complex Numbers and Quadratic Equations, Permutations and combinations, Binomial Theorem, sequences and series. Exponential and Logarithmic series.

[Scope as in Chapters 5, 7, 8, 9, Appendix 1 of a Textbook – 'Mathematics' for Class XI, NCERT.]

UNIT II (15 hrs)

Matrices, Operations on Matrices, Determinants, singular and non-singular matrices, Adjoint and inverse of a matrix [Scope as in Chapters 3 , 4 of a Text book- 'Mathematics' for Class XII, NCERT. Part I]

UNIT III (15 hrs)

Co-ordinate Geometry: Rectangular Coordinate system. Straight lines. Circles and family of circles. Parabola, Ellipse and Hyperbola-their equations in standard form. [Scope as in Chapters 10, 11 of a Textbook- 'Mathematics' for Class XI, NCERT.]

UNIT IV (15 hrs)

Three dimensional space, Coordinates of a point in three dimensional space. Distance between two points. Section Formula [Scope as in Chapter 12 of a Text book – 'Mathematics' for Class XI, NCERT.]

Suggested Readings

1. Mathematics, A Text book for Class XI and XII, NCERT, 2003 New Delhi.
2. Thomas Calculus, 12^{th} Edition, Pearson, 2014.

MAT-GE2-PS: Advanced Calculus and Geometry

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: The objective of the course is to equip the students with the knowledge of basic concepts and their applications in geometry.

UNIT I (15 hrs)

Vector-valued function and space curves. Arc length and unit tangent vector. Limit and continuity of multivariable function. Partial derivatives. Directional derivatives, gradiant vectors and tangent planes, Double integrals. Fubini's Theorem without proof, Change of order of integration in double integrals, double integrals in polar form (Chapters 11 Secs. 11.1, 11.3, Chapter 12.1-12.3, 12.7 and 13.1-13.3 of 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9^{th} Edition.

UNIT II (15 hrs)

Triple integrals in rectangular, spherical and cylindrical coordinates, substitution in multiple integrals. [Scope as in Sections 13.4, 13.6, 13.7 of Chapter 13 in the book 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9^{th} Edition.]

Line integrals vector fields. Path independence and surface integrals. Divergence and Stoke's theorem (Applications only). [Scope as in Sections 14.1, 14.3, 14.4, 14.5, 14.7 of Chapter 14 of the book 'Calculus and Analytic Geometry' by G. B. Thomas and R. L. Finney, 9^{th} Edition.]

UNIT III (15 hrs)

Transformation of axes, shifting of origin, reflection and rotation of axes, reduction of the equation $S=Ax^2+Bxy+Cy^2 +Dx+Ey+f=O$ into simpler forms by transformation of coordinate axes(without proof). Identification of curves represented by S=0. Invariance of discriminant and trace t. Condition that a second degree equation should represent a pair of straight lines. Polar coordinates, polar equation of a conic.

[Scope as in Chapters 1, 6(Sections 6.1-6.4), 7(Sections 7.1-7.8, 7.11-7.15) from Plane Geometry of "New Pattern Vector Algebra and Geometry" by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

UNIT IV (15 hrs)

Sphere, Cone, Cylinder, Equation of paraboloid, ellipsoid and hyperboloid in standard forms. Simple properties of these surfaces. Equation of tangent planes to the above surfaces.

[Scope as in Chapters 1(Sections 1.1-1.6, 1.11-1.14), 2(Sections 2.1-2.5, 2.12, 2.13), 3(Sections 3.1-3.3), 4(Sections 4.6, 4.7, 4.10, 4.11) from Solid Geometry of "New Pattern Vector Algebra and Geometry" by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

Suggested Readings

1. Thomas Calculus, 12th Edition, Pearson, 2014.
2. Shanti Narayan: Analytic Geometry.
3. J. P. Mohindru, Mrs. Usha Gupta & A. S. Dogra : New Pattern Vector Algebra and Geometry, International Publishers, New Edition(2004).
4. Schaum's Outlines, Vector Analysis, Tata McGraw-Hill Publishers, 2nd Edition.
5. Calculus and Analytical Geometry by G. B. Thomas and R. L. Finney, 9th Edition.

SEMESTER-II

MAT-GE4-BM: Calculus

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: This course is designed to introduce the fundamental concepts of continuity, differentiation and integration of functions of one variable. Its objective is to acquaint students with various applications of these topics relating to extreme value problems, problems of finding areas and distance travelled, moreover to describe connection between integral and differential calculus through Fundamental Theorem of Calculus.

UNIT I (15 hrs)

Continuity and Differentiability : Introduction. Limits. Continuity. Differentiability. Exponential and Logrithmic Differentiation. Derivative of a function in parameter Second order derivative . Mean Value Theorem [Scope as in Chapter 13 of a text book of Mathematics of XI & Chapter 5 of a text book- Mathematics for class XII Part- I NCERT].

UNIT II (15 hrs)

Application of derivative : increasing and decreasing functions. Maxima and Minima. Rolle's Theorem (without proof). Mean Value Theorem. Tangents and Normals. [Scope as in Chapters 6 of a Text book –'Mathematics' for Class XII, NCERT.]
Indeterminate forms, L'Hopital's Rule. Taylor and Maclaurin series(without proofs). [Scope as in Section 6.6 of Chapter 6 and Section 8.9 & 8.10 of Chapter 8 of a book 'Calculus' by Thomas & Finney, 9^{th} Edition.]

UNIT III (15 hrs)

Integral Calculus: Integral as antiderivative. Integration by substitution, by partial fractions and by parts. Definite integral and its properties. Areas of bounded regions. The definition of integral of a real valued function of real variable as limit of sum motivated by the determination of area. Fundamental theorem of integral

calculus.[Scope as in Chapters 7 &8 of a Text book- 'Mathematics' for Class XII, NCERT.Part II]

UNIT IV (15 hrs)

Differential Equations : Introduction & basic concepts. General and particular solutions of a differential Equation. Formation of differential equation.Metheds of solving First order, First degree Differential equations [Scope as in Ch 9 of a text book-Mathematics for class XII Part II]

Suggested Readings

1. Mathematics, A Text book for Class XI and XII (Parts I & II), NCERT 2003, New Delhi.
2. 'Calculus' by Thomas & Finney, 9th Edition, Pearson Education, 2004.
3. Thomas Calculus, 12th Edition, Pearson, 2014.

MAT –GE4-PS: Linear Algebra

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: This Course is a requirement for majors in other sciences because Linear Algebra provides a basis for advanced studies not only in Mathematics but also in other branches like engineering, physics and computers etc.

UNIT I (15 hrs)

Vector spaces over R and C, subspaces, linear span of vectors, linear independence and dependence, basis and dimension. Row rank, Column rank and determinantal rank of a matrix. Elementary row and column operations. Elemetary matrices. Row echelon form of a matrix. Equivalence of matrices. Reduction to normal form under equivalence(method only). The equality of three ranks(statement only).

UNIT II (15 hrs)

Methods of solving a system of equations with special reference to Gauss method, Matrix Inversion. Linear transformations. Rank and Nullity of a linear transformation, Inverse of a Linear Transformation. Rank and Nullity Theorem and its consequences. Matrix of a linear transformation with respect to a given basis.

[Scope as in Chapters 3(Sections 3.1-3.6), 4(Sections 4.1-4.5), 5(Sections 5.1, 5.2, 5.7-5.9) of the book 'Introduction to Linear Algebra' by V. Krishnamurthy, V.P.Mainra and J. L. Arora, East-West Press Pvt. Ltd.]

UNIT III (15 hrs)

Cayley-Hamilton Theorem. Characteristic roots and characteristic vectors of a square matrix. Nature of roots of different types of matrices, Minimal polynomial of a matrix.

UNIT IV (15 hrs)

Similarity of matrices, similarity reduction to a diagonal form, diagonalizable matrix, orthogonal reduction of real symmetric matrices. Unitary reduction of a Hermitian matrix (for these three reductions only the methods are expected to be taught. No proofs are expected to be taught).

[Scope as in 11(Sections 11.1-11.5, 11.11-11.13), 12(Sections 12.1-12.3), 13(Sections 13.1-13.4) of the book 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, 10^{th} edition, S. Chand & Co.]

References

1. V. Krishnamurty, V.P. Mainra and J. L. Arora, Introduction to Linear Algebra, East-West Press Pvt. Ltd. 1976.
2. Shanti Narayan and P. K. Mittal, A textbook of Matrices, S. Chand & Co., 2010.
3. Schaum's Outlines, Linear Algebra, Tata McGraw-Hill Publishers, 3^{rd} edition.

SEMESTER-III

MAT-C5: Theory of Real Functions

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: Introduction to the limit, continuity and derivatives real functions.

Unit I

Limit of a function (epsilon-delta approach), limit theorems, sequential criterion for limits, One-sided limits, Infinite limits, limits at infinity, Continuous functions, sequential criterion for continuity & discontinuity, Algebra of continuous functions, Composition of continuous functions.

Scope as in [1] Sections 4.1 to.4.3, 5.1, 5.2.

Unit II

Intermediate Value Theorem and its Applications, Extreme Value Theorem, Uniform Continuity, Continuity and Uniform Continuity.

Differentiability, Carathéodory's theorem, Algebra of differentiable functions, Chain Rule, Lipschitz Functions and Uniform Continuity, Inverse of Strictly Monotone Functions.

Scope as in [1] Sections 5.3, 5.4.1 to 5.4.3, 6.1.

Unit III

Local Extrema, Interior Extremum Theorem, Rolle's theorem, Mean Value Theorem and its Applications to inequalities & approximation of polynomials, Darboux's Theorem, L'Hospital's Rules.

Scope as in [1] Sections 6.2 and [2] 5.1 to 5.13.

Unit IV

Taylor's theorem and its application to inequalities, Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to Convex functions, Taylor's series & Maclaurin's series expansions of exponential & trigonometric functions.

Continuity of a Monotone function, functions of Bounded Variation, Total Variation of a function, the Total Variation Function, Rectifiable Curves.

Scope as in [1] Sections 6.1 to 6.4.6 and [3] Chapter 6.

Books Recommended

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. W. Rudin. *Principles of Mathematical Analysis*, 3rd edition. McGraw Hill, 1976.
3. T. M. Apostol, *Mathematical Analysis*, 2nd Edition, Narosa Publishing House, Reprint 2002.
4. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.
5. S. Abbott, Understanding Analysis, Springer Verlag, New York, 2008.
6. S. R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis,* Springer, 2006.
7. S. C. Malik and Savita Arora, *Mathematical Analysis,* 3rd Edition, New Age International Publishers, 2008.
8. M. H. Protter and C. B. Morrey, *A First Course in Real Analysis,* 2nd Edition, Springer Verlag, Indian Reprint, 2004.
9. C. C. Pugh, *Real Mathematical Analysis,* Springer Verlag, New York, 2001.
10. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.

MAT-C6: Group Theory – I

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note :
1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

Total Lectures: 60 **Credits: 6**

Objective*: The course is an introduction to Group Theory which is one of the most important subjects of algebra.*

UNIT-I

Symmetries of a square, Dihedral groups, binary operations, semigroups, groups, groups of integers modulo n, matrix groups, groups of quaternions, symmetric groups, cycle notation for permutations, even and odd permutations, property of permutations. Elementary properties of groups, subgroups, examples of subgroups, order of group elements, centralizer, normalizer, center of a group, product of two subgroups.

(Scope as in chapters 1-3 of [1])

UNIT-II

Cyclic groups, classification of subgroups of cyclic groups, subgroups generated by a subset, generators and relations, generators of Sn and An, Cosets and Lagrange's theorem and consequences including Fermat's Little theorem, Normal subgroups, Quotient groups,

(Scope as in chapters 4, 5, 7,9 of [1])

UNIT-III

Homomorphisms, Isomorphism Theorems, Cayley's Theorem, Automorphism, Inner automorphism, automorphism group, automorphism group of finite and infinite cyclic groups, automorphism group of Klein's four group. Inner automorphism group as factor group of the group.

(Scope as in chapters 6,10 of [1])

UNIT-IV

External and internal direct products and their properties, the group of units modulo n as an external direct product. Cauchy's theorem for finite abelian groups, Fundamental theorem for finite Abelian groups and its applications. Elementary divisors and invariant factors of finite Abelian groups.

(Scope as in chapters 8, 9, 11 of [1])

References

1. **Joseph A. Gallian,** *ContemporaryAbstractAlgebra,* **4th Ed., Narosa Publishing House, New Delhi, 1999.**
2. **John B. Fraleigh,** *A First Course in Abstract Algebra***, 7th Ed., Pearson, 2002.**
3. **M. Artin,** *Abstract Algebra***, 2nd Ed., Pearson, 2011.**
4. **Joseph J. Rotman,** *An Introduction to the Theory of Groups,* **4th Ed., Springer Verlag, 1995.**
5. **I. S Luthar and I.B.S. Passi : Algebra Volume 1:Groups, Narosa Publishing House, 1999.**
6. **I.N. Herstein,** *Topics in Algebra***, Wiley Eastern Limited, India, 1976.**
7. **Surjeet Singh Qazi Zameeruddin : Modern Algebra, 7th Ed., Vikas Publishing House, New Delhi, 1993**

MAT-C7: PDE and System of ODE

THEORY

4 hrs. per week
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time: 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 40 **Credits: 4**

Objective: To study Ordinary differential equations in more than two variables, Partial differential equations of the first and second order and systems of linear equations.

Unit I

Ordinary differential equations in more than two variables-Surfaces and curves in three dimensions, Simultaneous differential equations of first order and the first degree in three variables, Methods of solutions of $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$, Orthogonal trajectories of a system of curves on a surface, Pfaffian differential forms and equations, Solution of Pfaffian differential equations in three variables. (I N Sneddon, Chapter 1, section 1.1-1.6)

Unit II

Partial differential equations of the first order-Partial differential equations, Origins of first order partial differential equations, Cauchy's problem for first order equations, linear equation of first order, Integral surface passing through a given curve, Surfaces orthogonal to a given system of surfaces, Non-linear partial differential equation of the first order, Cauchy method of characteristics, Compatible system of first order equations, Charpit's method, Special types of first order equations, Solutions satisfying given conditions, Jacobi's method, Applications of first order equations. (I N Sneddon, Chapter 2)

Unit III

PDEs of second order-The origin of second order equations, Linear pdes with constant coefficients, separation of variables. Solution of Laplace equation, Heat equation and Wave equation with separation of variables in two dimensions. (I N Sneddon, Chapter 3).

Unit IV

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions. (S L Ross, Chapter 7, Section 7.1-7.4)

Books Recommended

1. I N Sneddon, Elements of Partial differential equations, Dover Publications, Inc. Newyork, 2006.
2. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists andEngineers,* 4th edition, Springer, Indian reprint, 2006.
3. S.L. Ross, *Differential equations,* 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.
5. W E Boyce and R C Diprima, Elementary Differential Equations and boundary value problems, John Wiley and Sons Inc., New York.

MAT-C7: PDE and System of ODE

PRACTICAL
(Using any software)

(3 practicals per week)
In groups of 15 students
[Max. Marks: 50](Final 40+Internal Assessment-10)
Time : 3hrs.

Total Lectures : 20 **Credits: 2**

List of Practicals (using any software)

(i) Solution of Cauchy problem for first order PDE.
(ii) Finding and plotting the characteristics for the first order PDE.
(iii) Plot the integral surfaces of a given first order PDE with initial data.
(iv) Solution of one dimensional heat equation.
(v) Solution of wave equation with associated conditions.
(vi) Solving system of ODEs.

Books Recommended

1. I N Sneddon, Elements of Partial differential equations, Dover Publications, Inc. Newyork, 2006.
2. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers,* 4th edition, Springer, Indian reprint, 2006.
3. S.L. Ross, *Differential equations,* 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.
5. W E Boyce and R C Diprima, Elementary Differential Equations and boundary value problems, John Wiley and Sons Inc., New York.

GENERIC ELECTIVE COURSE

(For students with background in Mathematics)

MAT-GE5-PS: Differential Equations and Fourier Series

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: The objective of the course is to enable the students to understand the basic concepts related to ordinary differential, partial differential equations and Fourier Series and their applications.

UNIT I

Exact First Order Differential Equations, Linear second order equations. Homogeneous equation with constant coefficients, Characteristic equation and their roots. Non-homogeneous equations of second order, Particular integrals, method of variation of parameters.

UNIT II

Solution in series of second order linear differential equations with variable coefficients (in particular, solutions of Legendre's and Bessel's equations.)
Bessel functions, Legendre functions, their recurrence and orthogonal relations, Gamma and Beta functions.

UNIT III

Fourier Series; Periodic functions. Fourier series and Fourier coefficients. Functions having arbitrary period. Sine and Cosine series. Half-range expansions. Exponential and complex form of Fourier series. Differentiation and integration of Fourier series. Fourier integrals.

UNIT IV

Formation of first and second order of partial differential equations and their classification, solution of first order equation, Lagrange's equation. Solution of Laplace, diffusion and wave equations by method of separation of variables. D'Alembert's solution of wave equation.
[Scope as in Sections 1.5.4, 4.6, 5.3.1, 5.3.2, 5.3.4, 5.4.1, 5.5, 6.1-6.4, 7.2, 7.4, 7.4.1, 7.5.1, 8.1, 8.2, 8.3, 8.5.4, 8.6 of Ref.1.]

Suggested Readings

1. R. K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics (Narosa Publishing House), 2nd edition, 2003.
2. Sokolnikoff and Redheffer : Mathematics for Physics and Engineering, McGraw-Hill, 2nd Edition, 1966..
3. Erwin Kreyszig : Advanced Engineering Mathematics (Wiley Eastern Limited), 8th edition, 2006.
4. R. V. Churchill & J. W. Brown : Complex Variables and Application, 4th Edition, McGraw Hill, NY, 1984.

(For students without background in Mathematics)

MAT-GE5-BM: Matrices

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
4. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
5. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective : This course familiarizes the students with the theory of matrices which are used in solving equations in mechanics and other streams used in Mathematics, Physics etc.

UNIT – I

Symmetric and Skew symmetric, Hermitian and Skew Hermitian, Orthogonal and Unitary matrices (Definitions and examples only).
Rank of a matrix, elementary transformations, reduction to normal form (methods only), elementary matrices, equivalence of matrices.
[Scope as in Chapter 1, 2, 4 of 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi**,** Reprint 2002].

UNIT - II

Vector as n-tuples. Linear dependence and independence of vectors. Rank of a matrix.
Row rank, Column Rank and Determinental Rank of a matrix.
System of linear equations, consistency and inconsistency. Homogeneous and non-homogeneous equations. Gauss method of solving a system of equations.
[Scope as in Chapter 5(Sections 5.1-5.8), Chapter 6(Sections 6.1-6.6) of 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi**,** Reprint 2002.]

UNIT - III

Characteristic equation of a square matrix. Characteristic roots and characteristic vectors. Nature of Characteristics roots of special matrices. Cayley-Hamilton Theorem (statement only). Orthogonal reduction of real symmetric matrices. (method only)
[Scope as in Chapters 11(Sections 11.1-11.4, 11.11) Chapter 12(Sections12.1, 12.2) of 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi**,** Reprint 2002.]

UNIT - IV

Unitary reduction of Hermitian matrices(method only). Similarity of matrices. Reduction to Diagonal form, diagonalizable matrices.
[Scope as in Chapter 12(Sections 12.3-12.5), Chapter 13(Sections 13.1-13.4) of 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002.]

Suggested Readings

1. Shanti Narayan & P. K. Mittal, A Text Book of Matrices, S. Chand & Co. Ltd., New Delhi, Reprint 2002.
2. R.K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics (Narosa Publishing House), 2nd edition, 2005.

MAT-SEC-1 Logic and Sets

[2 hrs/per week]
[Max. Marks: 50]
(Final-40+Internal Assessment-10)
Time : 3hrs.

Total Lectures : 20 **Credits: 2**

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, n- ary relations.

Books Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950

MAT-SEC-2 LaTeX and HTML

(3 practicals per week) In groups of 15 students
[Max. Marks: 50] (Final 40+Internal Assessment-10)
Time : 3hrs.

(2 hrs/week)
Credits - 2
Total Lectures 20

Objective : The objective of this syllabus is to teach computer fundamentals and introduction to 'C' Language. This will help students to learn about functioning of computers and familiarity with computer Language 'C' and also learn about create a web pages through HTML.

LaTeX: This Will help Student to Typesetting of journal articles, technical reports, thesis, books, and slide presentations. Control over large documents containing sectioning, cross-references, tables and figures. Typesetting of complex mathematical formulae.

PART 1

Theoretical Concepts of UNIX Operating System : Basic Features of Operating System; Characters with special meaning; UNIX Documentation; DOS Commands and Files System;Directories : Current Directory , looking at the Directory contents, Absolute and Relative Pathnames, Some UNIX Directories and Files; Looking at File contents; File Permissions; Basic operation on Files; Changing Permission Modes; Standard files; Standard output; Standard input, Standard Error;

PART 2

Elements of LaTeX; Hands-on-training of LaTex; graphics in LaTeX; PSTricks; GeoGebra; Beamer presentation;

[1] Chapter 1-5,
[3] Chapter 9-11, 15

Practical

Six practical should be done by each student. The teacher can assign practical from the exercises from [1] and [3].

References:

1. Dass, Sumitabha : Your Unix the Ultimate Guide
2. Kernighan, Brian & Pike, Rob 1987 : The UNIX Programming Environment, Prentice Hall. Bach, Maurice 2007 : The Design of the UNIX Operating System, Prentice Hall.
3. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011. [2] L. Lamport. LATEX: A Document Preparation System, User's Guide and ReferenceManual. Addison-Wesley, New York, second edition, 1994.

SEMESTER-IV

MAT-C8: Numerical Methods

4 hrs.per week
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time: 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**
4. **Use of Scientific Calculator is allowed.**

Total Lectures: 40 **Credits: 4**

Objective: To acquaint the students with Numerical approximations, convergence problems, Different rules of Numerical integrations and numerical differentiation.

Unit-I

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation.

Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.

Unit-II

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

Unit-III

Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

Unit-IV

Ordinary Differential Equations: Numerical differentiation, Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta methods of orders two and four.

Books Recommended

1. Brian Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 6th Ed., New age International Publisher, India, 2007.
3. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 2008.
4. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods*, 7th Ed., PHI Learning Private Limited, 2013.
5. John H. Mathews and Kurtis D. Fink, Numerical *Methods using Matlab*, 4th Ed., PHI Learning Private Limited, 2012.

MAT-C8: Numerical Methods

PRACTICAL

(Using any software)

(3 practicals per week)
In groups of 15 students
[Max. Marks: 50](Final 40+Internal Assessment-10)
Time: 3hrs.

Total Lectures : 20 **Credits: 2**

List of Practicals (using any software)

(i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
(ii) To find the absolute value of an integer.
(iii) Enter 100 integers into an array and sort them in an ascending order.
(iv) Bisection Method.
(v) Newton Raphson Method. (vi) Secant Method.
(vii) Regulai Falsi Method.
(viii) LU decomposition Method. (ix) Gauss-Jacobi Method.
(x) SOR Method or Gauss-Siedel Method.
(xi) Lagrange Interpolation or Newton Interpolation. (xii) Simpson's rule.

Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

Books Recommended

1. Brian Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 6th Ed., New age International Publisher, India, 2007.
3. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 2008.
4. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods*, 7th Ed., PHI Learning Private Limited, 2013.
5. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, 4th Ed.,PHI Learning Private Limited, 2012.

MAT-C9: Riemann Integration and Series of Functions

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note:

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: Introduction to Riemann Integration, Improper Integrals, Uniform Convergence and Power Series.

Unit I

Riemann Integration, Upper and Lower Darboux Sums, Riemann Sums and definition of Riemann integral through Riemann sums, Cauchy Criterions for integrability, Equivalence of two definitions. The Class of Riemann integrable functions, Properties of the Riemann integral, Fundamental theorems of Calculus.

Scope as in [1] Chapter 6 (Art. 32.1 to 32.9, 33.1, 33.2, 33.3, 33.4 to 33.8, 33.9, 34.1, 34.3)

Unit II

Improper Integrals, Tests for Convergence of Improper Integrals, Beta and Gamma functions.
Scope as in [4] Chapter 11 and [2] 8.17 to 8.20.

Unit III

Point wise and Uniform Convergence of Sequence of functions, Weierstrass M-Test, Uniform Convergence and Continuity, Uniform convergence and Integration, Uniform convergence and differentiation, A Continuous nowhere differentiable function, Weierstrass Approximation Theorem.

Scope as in [2] 7.1 to 7.12, 7.16, 7.17, 7.18.

Unit IV

Power series, Radius of convergence, Cauchy-Hadamard Theorem, Differentiation and integration of power series, Taylor Series Theorem, Abel's Theorem, Multiplication of Two Series, Exponential, Logarithmic and Trigonometric functions.

Scope as in [2] 8.1 to 8.7.

Books Recommended

1. K.A. Ross, *Elementary Analysis, The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. W. Rudin. *Principles of Mathematical Analysis*, 3rd edition. McGraw Hill, 1976.
3. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
4. S. C. Malik and Savita Arora, *Mathematical Analysis,* 3rd Edition, New Age International Publishers, 2008.
5. Shanti Narayan, *A Course of Mathematical Analysis,* S. Chand and Company Ltd.1984.
6. Charles G. Denlinger, *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.
7. M. H. Protter and C. B. Morrey, *A First Course in Real Analysis,* 2nd Edition, Springer Verlag, Indian Reprint, 2004.
8. C. C. Pugh, *Real Mathematical Analysis,* Springer Verlag, New York, 2001.
9. S. K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.
10. S. Abbott, Understanding Analysis, Springer Verlag, New York, 2008.

MAT-C10: Ring Theory and Linear Algebra-I

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note:

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures : 6 **Credits: 6**

Objective: The course is an introduction to Ring Theory and Linear Algebra which is one of the most important subjects of algebra.

UNIT-I

Definition and examples of rings, properties of rings, subrings and ideals, integral domains, Division rings and fields, characteristic of a ring, ideals and factor rings, ideal generated by a subset of a ring, algebra of ideals, prime and maximal ideals.
(Scope as in Chapters 12-15 of [4])

UNIT-II

Polynomial Rings over commutative rings, division algorithm and consequences, remainder theorem, factor theorem, reducibility tests, irreducibility tests, Eisenstein's irreducibility criterion, Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients and Embedding Theorems.
(Scope as in Chapter 15-17 of [4])

UNIT-III

Duality**,** canonical forms, the minimal polynomial, diagonalizable and triangulable operators, Jordan and rational forms.
(Scope as in Chapter 2 and 3 of [9])

UNIT-IV

Inner Product Spaces , orthogonality, adjoint of a linear operator, Unitary Operators, Normal and Self- adjoint Operators. Polar and singular value decompositions, Bilinear Forms, the matrix of bilinear form, orthogonality, classification of bilinear form.
(Scope as in Chapter 4 and 5 of [9])

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *LinearAlgebra,* 4^{th} Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

4. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House ,New Delhi , 1999.
5. S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.
6. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
7. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India,1999.
8. KennethHoffman,RayAldenKunze,*LinearAlgebra,*2ndEd.,Prentice-HallofIndiaPvt. Ltd., 1971.
9. Vivek Sahai and Vikas Bist, *Linear Algebra*, 2nd Ed., Narosa Publishing house 2013.
10. P. B. Bhattacharya, S.K. Jain and S. R. Nagpaul , *First Course in Linear Algebra,* Wiley Eastern Limited.
11. D.A.R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.
12. I. S. Luthar and I. B. S. Passi, Algebra Volume II, Rings, Narosa Publishing House 1999.

MAT-SEC-3 Graph Theory

[2 hrs/per week]
[Max. Marks: 50]
(Final-40+Internal Assessment-10)
Time: 3hrs.

Total Lectures: 20 **Credits: 2**

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Books Recommended

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

MAT-SEC-4 Computer Algebra Systems and Related Software's

(3 practicals per week) In groups of 15 students
[Max. Marks: 50] (Final 40+Internal Assessment-10)
Time : 3hrs.

(2 hrs/week)
Credits - 2
Total Lectures 20

Objective: The objective of this course is to teach pointers, structures in 'C'. This paper also introduces mathematical packages from programming point of view to help Mathematics students to solve their problems.

PART 1

Shell Programming:
Programming in the Borne and the C-shell; Wild cards. Simple Shell Programs; Shell Variables; Shell Programming Constructs; Interactive Shell Scripts; Advanced Features.

PART 2

Use of Mathematica, Maple, and Maxima as calculator, in computing functions, in making graphs; MATLAB/Octave for exploring linear algebra and to plot curve and surfaces; the statistical software R: R as a calculator, explore data and relations, testing hypotheses, generate table values and simulate data, plotting.
[1] Chapter 5,8,10
[3] Chapter 12-14

Practical
Six practical should be done by each student. The teacher can assign practical from the exercises from [1] and [3]

References:

1. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011.
2. L. Lamport. LATEX: A Document Preparation System, User's Guide and Reference Manual. Addison-Wesley, New York, second edition, 1994.
3. Eric Faster–Johnson : Beginning Shell Scripting (Covers Linux, Unix Windows & Mac), Wiley India Pvt. Ltd.
4. Dass, Sumitabha : Your Unix the Ultimate Guide

GENERIC ELECTIVE COURSES

MAT-GE6-PS: Integral Transforms and Complex Analysis

(For students with background in Mathematics)

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note:

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures : 60 **Credits: 6**

Objective : To acquaint the students with the application of Laplace transforms to solve ordinary differential equations. Moreover, basics of Complex Analysis are also included in this course.

UNIT I

Laplace Transforms : definition, elementary transforms. Transforms of derivatives and integrals. Transforms of periodic functions. Convolution theorem. Inverse Laplace transforms. Application to ordinary differential equations.

UNIT II

Complex numbers, absolute value, argument. Functions e^z, sin z, cos z, log z and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Harmonic functions and their conjugates.

UNIT III

Integration of complex functions, Cauchy's theorem (statement only), Cauchy's theorem for multiply connected domains (statement only). Cauchy's integral formula (statement only) and simple consequences.

UNIT IV

Expansion into Laurent series, singularities, Residues, Cauchy residue theorem (statem*ent only). Evaluation of definite integrals using contour integration.*
[Scope as in relevant sections of Chapter 1-6 of Ref. 4.]

Suggested Readings

1 R. K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics (Narosa Publishing House), 2nd edition, 2004.
2 Sokolnikoff and Redheffer : Mathematics for Physics and Engineering 2nd Edition, 1996.
3 Erwin Kreyszig: Advanced Engineering Mathematic (Wiley Eastern Limited), 10th Edition, 2011.
4 R. V. Churchill & J. W. Brown : Complex Variables and Application, 4th Edition,1995.

(For students without background in Mathematics)

MAT-GE6-BM: Vector Analysis, Differential Equations and Transforms

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note:

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: The aim of this course is to make the students acquire facility and confidence in the use of vectors and vector calculus so that they may employ the same in an effective manner to various applications and to exhibit the techniques of solving ordinary and partial differential equations.

UNIT - I

Vector valued functions. Limit and continuity of vector functions. Differentiation of vector functions., Arc length., Line, Surface and Volume integrals. The gradient, divergence and curl. The del operator. Green's, Gauss' and Stokes' theorems (statements only). Applications to physical problems.
[Scope as in Chapters 9-11 of 'A Text Book of Vector Analysis' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Revised Edition 2003.]

UNIT - II

Differential Equations and their solutions, Equations with variables separable, Homogeneous equations, First order linear equations.
Homogeneous and nonhomogeneous ordinary differential equations of second order with constant co-efficients. Wronskian and Linear independence and dependence of solution, particular integral, D-operator method, method of variation of parameters.
[Scope as in Sections 4.5-4.7, 5.1, 5.2, 5.3.1, 5.3.2, 5.4.1, 5.5 of Ref.4.]

UNIT - III

The Laplace transforms, Shifting theorem. The Convolution theorem. Inverse transform, Applications to ordinary differential equations. Legendre polynomials. Their recurrence and orthogonal relations.
[Scope as in Sections 8.1-8.4, 8.5.4, 7.2 of Ref.4.]

UNIT - IV

Formation of first and second order partial differential equations, solutions of first order equation, classification of linear second order equations, separation of variables, solution of one dimensional wave and heat equations, solution of Laplace equation.
[Scope as in Sections 16.2, 16.3.1, 9.5.1, 9.5.2, 9.5.3, 9.5.4, 9.5.5 of Ref.4.]

Suggested Readings

1. H. F. Davis & A. D. Snider, Introduction to Vector Analysis, Allyn and Bacon, Inc., Boston, USA, 1995.
2. Shanti Narayan & P. K. Mittal, A Text Book of Vector Analysis, S. Chand & Co. Ltd., New Delh, 2003.
3. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern Ltd., N. Delhi, Revised Edition 2003.[
4. R.K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics(Narosa Publishing House), 2nd edition, 2005.

SEMESTER - V

C11 Multivariate Calculus

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note:

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures : 60 **Credits: 6**

Use of Scientific calculator is allowed.

Objective: To apprise the students with theory of functions of several variables, its derivatives double and triple integrals and change of order of integration.

Unit I

Functions of several variables, limit and continuity of functions of several variables, partial differentiation, directional derivatives, total differentiability, Jacobian matrix, Chain rule.

Mean value theorem for differentiable functions, sufficient condition for differentiability, symmetry of mixed partial derivatives, Taylor's formula for real valued functions of several variables.

Unit II

The gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of several variables, method of Lagrange multipliers, constrained optimization problems.

Banach Contraction principle, Inverse function theorem and implicit function theorem.

Unit III

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, cylindrical and spherical co-ordinates.

Change of variables in double integrals and triple integrals. Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.

Unit IV

Definition of vector field, divergence and curl, Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.

Scope:

Units I and II: Chapter 12-13 from [1],
Units III and IV: Chapters 15 and 16 from [2].

Scope as in

Books Recommended

1. T. M. Apostol, *Mathematical Analysis*, 2nd Edition, Narosa Publishing House, Reprint 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, 12th Ed., Pearson Education, Delhi, 2014.
3. W. Rudin. *Principles of Mathematical Analysis*, 3rd edition. McGraw Hill, 1976.
4. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
5. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer (SIE), Indian reprint, 2005.
6. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

MAT-C12 : Group Theory II

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: Group Theory is a mathematical concept which is used as a tool in almost all branches of science. This is an advanced course in group theory and MAT C6 is a prerequisite for this course.

Unit-I

Automorphism, Inner automorphism, automorphism group, automorphism group of finite and infinite cyclic groups, automorphism group of Klein's four group. Inner automorphism group as factor group of the group, Characteristic subgroups, Commutator subgroup and its properties.

Unit-II

Group actions, group acting on themselves by left multiplication and conjugation. Stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions, Generalized Cayley's theorem, Index theorem. Class equation as a consequence.

Unit-III

p-Groups, Sylow's theorems and its applications. Semidirect products. Groups of order p^2, p^3, pq. Classification of groups of order upto 20.

Unit-IV

Normal and subnormal series, Derived series, composition series, solvable groups and nilpotent groups, Zassenhaus lemma, Schreier refinement theorem, Jordan Holder's theorem
Scope as in 3, 4, 5, 6 of [2]

Books Recommended

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed. Pearson, 2002.
2. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Ed., John Wiley and Sons(Asia) Pvt. Ltd., Singapore, 2004.
3. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
4. I.S. Luthar and I.B.S. Passi, Algebra, Volume 1: Groups, Narosa Publishing House, 1996.
5. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.

MAT DSE 1 : Number Theory

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures : 60 **Credits: 6**

Objective : The aim of this course is to teach the students about the basics of Elementary Number Theory starting with primes, congruences, quadratic residues, primitive roots, arithmetic functions. Apart from teaching the theory, stress will be on solving problems.

UNIT-I

Divisibility, Greatest common divisor, Euclidean algorithm, The Fundamental theorem of arithmetic, Congruences, Residue classes and reduced residue classes, Chinese remainder theorem, Fermat's little theorem.

UNIT-**II**

Wilson's theorem, Euler's theorem and its application to a cryptography, Arithmetic functions ϕ (n), d(n), σ(n), μ(n), Mobius inversion formula, Greatest integer function.

UNIT-III

Primitive roots and indices. Quadratic residues, Legendre symbol, Euler's criterion, Gauss's lemma, Quadratic reciprocity law, Jacobi symbol.

UNIT-IV

Representation of an integer as a sum of two and four squares. Diophantine equations $ax + by = c$, $x^2+y^2=z^2$, $x^4+y^4=z^2$. Binary quadratic forms and equivalence of quadratic Forms. Perfect numbers, Mersenne primes and Fermat numbers, Farey fractions.

References:

1. G. H. Hardy and E. M. Wright – An Introduction to Theory of Numbers, *Oxford* University Press, 6th Ed , 2008.
2. I. Niven, H. S. Zuckerman and H. L. Montgomery – An Introduction to the Theory of Numbers, John Wiley and Sons, (Asia) 5th Ed., 2004.
3. H. Davenport - The Higher Arithmetic, Camb. Univ. Press, 7th edition, (1999)
4. David M. Burton – Elementary Number Theory, Tata McGraw Hill, 6th Edition, 2007.

MAT DSE 2 - Probability and Statistics

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: This course provides an introduction to probability theory, random variables, mathematical statistics, Central Limit theorem and Markov chains, learn commonly used probability distributions and their uses in real life. Probability theory is important because of its direct application in areas such as genetics, finance and telecommunications. It also forms the fundamental basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modelling.

Unit I

Sample Space, review of set theory, events, probability function, probability axioms, the concept of real random variables (discrete and continuous), cumulative distribution function, probability mass / density functions, conditional probability, mathematical expectation, moments, moment generating function, characteristic function.

Unit II

Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial. Continuous distributions: uniform, normal, exponential, Log-normal distribution, Pareto distribution.

Unit III

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

Unit IV

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata Mc Graw- Hill, Reprint 2007.

MAT DSE 3 : Discrete Mathematics

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures : 60 **Credits: 6**

Objective: The objective of this course is to acquaint the students with the basic concepts in Discrete Mathematics and Graph Theory.

UNIT-I

Pigeonhole principle, Basic counting principles, permutations and combinations of sets and multi sets, Binomial and multinomial theorems, Combinatorial identities, inclusion and exclusion principle, Recurrence relations.

UNIT-II

Generating functions solution of recurrence relations using difference equations and generating functions, Catalan numbers, Difference sequences and Sterling numbers. Partitions as associated to distribution identical objects in identical boxes.

UNIT-III

Elements of Graph Theory, Eulerian and Hamiltonian trails and cycles. Bipartite multigraphs, Trees, Planer graphs, Euler formula.

UNIT-IV

Spanning Trees, Algorithams for BFS and DFS trees weighted Graphs, Greedy algorithm and Prim's Algorithm for generating minimum weight spanning graphs, Digraphs, and Chromatic numbers. (Scope as in Introductory Combinatorics, 5th Edition by R.A. Brualdi , Chapters 1-3,5-8,11 (except § 11.6), 12 .1, 13.1,13.2)

Suggested Readings

1. R.A. Brualdi: Introductory Combinatorics, 5th Edition, Pearson, 2010.
2. J. L. Mott, Kandel and T. P. Baker: Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall, 1986.

MAT DSE 4: Statics

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: Mechanics is one of the important branches of mathematics that finds application in almost all real world problems. This course is an introduction to statics, that is, the bodies at rest under action of forces. Students will be introduced to the concept of force, their addition and resolution, moments, couples, friction and equilibrium conditions. In addition, the centre of mass, gravity and stability of body will be taught.

UNIT-I

Basic notions: Inertial and non-inertial frame of reference, Weight of body, Force, Force with contact and without contact, Force systems, Principle of transmissibility of forces, Basic concepts of mechanics.

Forces acting on a particle: Parallelogram law of forces, Triangle law of forces and its converse, Polygon of forces, λ-μ Theorem, Lami's theorem and its converse, Components of a force in given directions.

Resolution of forces, Theorem on resolved parts of two and more concurrent forces. Condition of equilibrium of any number of forces, Trignometric m-n theorem, equilibrium of a rigid body under the action of three forces.
(Scope as in Chapters 1, 2, 3 and 7 of S L Loney and Chapter 3 of A S Ramsey; All the relevant unsolved exercises of these chapters must be covered)

UNIT-II

Parallel forces: Resultant of two like parallel forces, unequal unlike parallel forces, Theorem of resolved parts of two parallel forces, Centre of parallel forces, Centre of gravity.

Moments and Couples: Moment of a force about a point, Moment of a force about a line; Couple, Moment of a couple, Varignon's theorem on moments of two coplanar forces. Composition of coplanar couples, Composition of a number of couples, equilibrium of couples, equivalence of couples.

(Scope as in Chapters 4, 5, 6 and 9 of S L Loney and Chapter 4 of A S Ramsey; All the relevant unsolved exercises of these chapters must to be covered)

UNIT-III

Coplanar forces: Resultant of a system of coplanar forces, Resultant of three coplanar forces to two, Reduction of any number of coplanar forces to a single force or a single couple, Generalization theorem of resolved parts, generalisation of Varignon's theorem of moments, Condition of equilibrium of a system of coplanar forces, Reduction of two coplanar forces to a single force or a single couple

Resultant of a force and a couple, Resolution of a force into a force and a couple, Reduction of a system of coplanar forces to a force and a couple.

(Scope as in Chapters 5 & 6 of A S Ramsey and Chapter 8 of S L Loney, All the relevant unsolved exercises of these chapters must to be covered)

UNIT-IV

Friction: Definition and nature of friction, coefficient of friction, angle of friction, cone of friction, laws of friction, equilibrium of a particle on a rough plane, Problems on ladders, rods etc.

Virtual Work: Work done by a force, Principle of virtual work with Applications

(Scope as in Chapter 9 of A S Ramsey and Chapter 14 &15 and 17 of in S. L. Loney; All the relevant unsolved exercises of these chapters must to be covered)

Suggested Readings:

1. The Elements of Statics and Dynamics: Part 1 (Statics) by S. L. Loney, Published by Arihant Prakashan, Meerut.
2. Statics by A. S. Ramsey, Second Edition, CBS Publishers.

SEMESTER - VI

C13 Metric Spaces and Complex Analysis

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures : 60 **Credits: 6**

Objective: Introduction to metric spaces and the theory of analytic functions.

Unit I

Metric spaces: definition and examples, balls and bounded sets, sequences in metric spaces, convergent and Cauchy sequences, open sets, closed sets, limit points, subspace topology, limits and continuity, homeomorphisms, Complete Metric Spaces, Cantor intersection property, totally bounded sets.

Unit II

Compact sets, Heine Borel theorem, sequential compactness, Bozano Weierstrass property, finite intersection property, continuity and compactness, uniform continuity, Dense sets, separable sets, perfect sets, connectedness, connected subsets of reals, continuity and connectedness, connected components, path connectedness.

Unit III

Axiomatic approach to complex numbers, Stereographic projection, Simply Connected regions, Branches of multi-valued functions, Principle Logarithm, complex exponents, Derivative of a complex function, Cauchy-Riemann equations, sufficient conditions for differentiability, Differentiation of Elementary functions, Analytic functions, Harmonic functions and their Conjugates, Analyticity at Infinity.

Unit IV

Curves, Simply closed curves, Complex line integral, Path independence of a line integral, Cauchy's theorem for Rectangles and Disks, the Cauchy Integral Formula and Applications, Liouville's theorem and its consequences, Absolute and Uniform Convergence of Power Series, Introduction to Taylor and Laurent series and their examples.

Scope:

Units I and II: Chapter 4 from [1], Chapter 2 and 4 from [2] and Chapter 7 of [3],.
Units III and IV: Sections 1.1, 1.6, 2.4 to 2.7, 3.2, 3.5, 3.6, 3.7, 4.1 to 4.8, 6.1, 6.2, 6.3, 6.5. from [4].

Books Recommended

1. T. M. Apostol, *Mathematical Analysis*, 2nd Edition, Narosa Publishing House, Reprint 2002.
2. W. Rudin. *Principles of Mathematical Analysis*, 3rd edition. McGraw Hill, 1976.
3. N. L. Carothers, *Real Analysis*, Cambridge University Press 2000.
4. H. S. Kasana, Complex Variables: Theory and Applications (2nd Edition), Prentice-Hall of India Pvt Ltd, New Delhi, 2005.
5. S. Punnusamy, Foundations of Complex Analysis (2nd Edition), Narosa Publishing House, New Delhi, 2005.
6. Satish Shirali and Harikishan L. Vasudeva, *Metric Spaces*, Springer Verlag, London, 2006.
7. S. Kumaresan, *Topology of Metric Spaces*, 2nd Ed., Narosa Publishing House, 2011.
8. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill, 2004.
9. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications,* 8th Ed., McGraw – Hill International Edition, 2009.
10. Joseph Bak and Donald J. Newman, *Complex Analysis,* 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.

MAT C14: Ring Theory and Linear Algebra-II

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note:

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures : 60 **Credits: 6**

Objectives: This is an advanced course in ring theory and linear algebra. MAT C10 is a prerequisite for this course.

UNIT-I

Factorization and Divisibility in integral domains, Unique Factorizaion Domains (UFDs), Principal Ideal Domains (PIDs), Euclidean domains and relationships between them.

UNIT-II

Primitive Polynomials and Gauss Lemma, Eisenstein's irreducibility criterion, Factorization of polynomials in one variable over a field, Unique Factorization in R[X], R a UFD.

Scope as in Chapters 8 and 9 of [9]

UNIT-III

Modules, definition and examples, Submodules, Quotient modules, Free modules, Comparison with vector spaces, Homomorphisms, Simple and Semisimple Modules.

UNIT-IV

Structure of finitely generated modules over a PID. Rational and Jordan Canonical forms.

Scope as in Chapters 10 and 12 of [9]

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, 1999.
4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4thEd., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
5. S. Lang, *Introduction to Linear Algebra,* 2nd Ed., Springer, 2005.
6. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
7. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India, 1999.
8. Kenneth Hoffman, Ray Alden Kunze, *LinearAlgebra,*2ndEd.,Prentice-HallofIndiaPvt. Ltd., 1971.
9. David S. Dummit and Richard M. Foote, Abstract Algebra, John Wiley and Sons 2004.
10. I. S. Luthar and I.B.S. Passi: Algebra Volume 2 and 3 Rings, Modules, Narosa Publishing House 1999.

MAT DSE 5 - Linear Programming

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

Note **:**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: To provide the knowledge of basic concepts of optimization problems, theoretical development and applications of various techniques to solve real world problems, which can be formulated as linear programs.

Unit I

Convex sets, half spaces and their properties, Convex hull of a set, Convex polytopes and polyhedrons, Hyperplane, Caratheodory's theorem, extreme points and their existence, Supporting hyperplanes, Separating Hyperplanes, their existence, Separation theorems. (Scope as in chapter 2 of Ref1,chapter 2 of Ref 2)

Unit II

Linear Programming problems, basic feasible solution, mathematical formulation of practical problems, graphical method for the solution of linear programming problems, Basic solutions and extreme points. Fundamental properties of Linear programs, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.(Scope as in chapter3,4,5 of Ref1)

Unit III

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual. Theorem of Weak duality, strong duality, Basic duality theorem, Weak complementary slackness theorem, Strong complementary slackness theorem, their applications, Application of Duality to Farkas' lemma and solutions of linear inequalities.(scope as in chapter 15 of Ref 3)

Unit IV

Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, Properties of coefficient matrix , triangular basis, UV algorithm for solving transportation problem, unbalanced transportation problems, time minimization transportation problem, Paradox in Transportation problem**,** assignment problem and its mathematical formulation, Hungarian method for solving cost minimization assignment problem and its convergence, time minimization assignment problem.(Scope as in chapter 5 of Ref 2,Chapter 5 of Ref 4).

References

1. G.Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
2. N.S. Kambo, Mathematical programming, East West Press, 1991.
3. S.M. Sinha, Mathematical Programming Theory and Methods, Elsevier, 2006.
4. Suresh Chandra, Jayadeva, Aparna Mehra, Numerical Optimization with Applications, Narosa Publishing House,2009
5. Mokhtar S.Bazaraa, John J.Jarvis and Hanif D. Sherali, Linear Programming and Network Flows,2nd edition., John Wiley and Sons,India,2004.
6. F. S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Edition, Tata McGraw Hill, Singapore,2009.

MAT DSE 6: Dynamics

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time: 3hrs.

Note:

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: Mechanics is one of the important branches of mathematics that finds application for bodies in motion. This course is to study the motion of moving body. Students will be introduced to the concept of motion along a straight line with constant and variable acceleration. In addition, motion in a plane, SHM, projectile, work, power energy, momentum and impulsive motion will be taught.

UNIT-I

Basic notions: Kinematics, kinetics, uniform motion, position, displacement, velocity, acceleration, uniform velocity, Linear momentum.

Motion of a particle in a straight line: Motion of a particle with constant acceleration, motion of a body let fall free from rest, motion of a body projected vertically upwards.
(Scope as in Chapter 1, 3 and 4 of A S Ramsey; All the relevant unsolved exercises of these chapters must be covered)

UNIT-II

Newton's Laws of Motion: Newton's Laws of Motion, Motion of two particles connected by a string, Motion along a smooth inclined plane, constrained motion along a smooth inclined plane.

Variable acceleration: Simple harmonic motion.
(Scope as in Chapter 4, 5 & 11 of S L Loney; All the relevant unsolved exercises of these chapters must to be covered)

UNIT-III

Motion of a particle in a plane: Composition and resolution of velocities and Acceleration in a plane, Projectiles, motion in a circle, Motion under constraint.

Work and energy: Work, Conservative fields and the potential energy, work done against gravity, Potential energy of a gravitational field.

(Scope as in Chapter 6, 7, 9 and 10 of S L Loney: All the relevant unsolved exercises of these chapters must be covered)

UNIT-IV

Relative motion: Relative displacement, velocity and acceleration, motion relative to a rotating frame of reference.
Momentum: Linear momentum, angular momentum, conservation of angular momentum, impulsive forces, principle of impulse and momentum, motion with respect to centre of mass of a system of particles.
Impulsive motion: Collisions of elastic bodies, loss of energy during impact.

(Scope as in Chapters 6 & 8 of S L Loney and Chapter 10 and 11 of A S Ramsey: All the relevant unsolved exercises of these chapters must be covered)

Suggested Readings:

1. Dynamics by A. S. Ramsey, Cambridge University Press.
2. The Elements of Statics and Dynamics: Part 2 (Dynamics) by S. L. Loney, Arihant Prakashan, Meerut.

DSE-7: Differential Geometry

[6 hrs/per week (including Tutorials)]
[Max. Marks: 150]
(Final-120+Internal Assessment-30)
Time : 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: In this course the tools of calculus, differential equations and linear algebra acquired in courses C1, C3, C4, C5, C9, C11 will be used to study problems in geometry.

Unit I

Theory of Space Curves: Curves in the planes and in space, arc length, reparametrization, curvature, Serret-Frenet formulae. osculating circles, evolutes and involutes of curves, apace curves, torsion, Serret-Frenet formulae.

Unit II

Theory of Surfaces Surfaces, smooth surfaces, tangents, normals and orientability, quadric surfaces, the first and the second fundamental forms, Euler's theorem. Rodrigue's formula.

Unit III

Gaussian Curvature, Gauss map and Geodesics: The Gaussian and mean curvatures, the pseudosphere, flat surfaces, surfaces of constant mean curvature, Gaussian curvature of compact surfaces, the Gauss map, Geodesics, geodesic equations, geodesics of surfaces of revolution, geodesics as shortest paths, geodesic coordinates.

Unit IV

Minimal Surfaces and Gauss's Remarkable Theorem: Plateau's problem, examples of minimal surfaces, Gauss map of a minimal surface, minimal surfaces and holomorphic functions, Gauss's Remarkable Theorem, isometries of surfaces, The Codazzi-Mainardi Equations, compact surface of constant Gaussian curvature

Books Recommended

1. Andrew Pressley, Elementary Differential Geometry, Springer, Fourth Indian Reprint 2009.
2. T.J. Willmore, *An Introduction to Differential Geometry*, Dover Publications, 2012.
3. B. O'Neill, *Elementary Differential Geometry*, 2nd Ed., Academic Press, 2006.
4. C.E. Weatherburn, *Differential Geometry of Three Dimensions*, Cambridge University Press 2003.
5. D.J. Struik, *Lectures on Classical Differential Geometry*, Dover Publications, 1988.
6. S. Lang, *Fundamentals of Differential Geometry*, Springer, 1999.
7. B. Spain, *Tensor Calculus: A Concise Course*, Dover Publications, 2003.

MAT DSE 8: Mathematical Modeling

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

***Note* :**

1. **The question paper will have nine questions. Question No.1 spread over thewhole syllabus will be compulsory. Candidates will attempt five questions.**
2. **There will be two questions from each unit and the students will be required to answer one question from each unit.**
3. **All questions carry equal marks.**

Total Lectures: 60 **Credits: 6**

Objective: This course apprises basic concepts of mathematical modelling, some special functions and some basic models.

Unit I

Introduction to mathematical modelling, modelling approaches: (Empirical, Stochastic, Simulation, Deterministic, and Statistical models), Classifications and some characteristics of Mathematical Modelling, limitations of Mathematical Modelling.

Modeling of Differential Equations:
Compartmental models: Exponential decay and radioactivity, detecting art forgeries, lake pollution models (case study of lake burley griffin), Drug assimilation into the blood (a single fast-dissolving cold pill, course of slowly dissolving cold pills), equilibrium points and stability, Models of single populations, Density-dependent growth, Limited growth with harvesting, Discrete population growth and chaos, Time-delayed regulation (Scope as in Chapter 1,2,3 of Ref [3]),
The Differential Equation of the Vibrations of a Mass on a Spring, Free, Undamped Motion, Free, Damped Motion, Forced Motion, Resonance Phenomena, Electric Circuit Problems, (Scope as in Chapter 5 of Ref [4])

Unit II

Interacting population models: Model for an influenza outbreak, Cholera, Predators and prey, Competing species, Model of a battle, Analysis of a battle model, Analysis of a predator-prey model, Analysis of competing species models (Scope as in Chapter 5, 6 of Ref [3]).

Laplace transform and inverse transform application to initial value problem with constant coefficients and with discontinuous non homogeneous terms, (Scope as in Chapter 9 of Ref [4]).

Unit III

Monte Carlo Simulation Modelling: simulating deterministic behaviour (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence, Fitting Models to Data Graphically, Analytic Methods of Model Fitting, Applying the Least-Squares Criterion, Probabilistic Modeling with Discrete Systems, Modeling Component and System Reliability, Linear Regression, (Scope as in Chapter 3, 5 and 6 of Ref [2]).
Markov Model: Examples of Markov Chains, nth step transition matrix, irreducible Markov chain and classification of states, Simulation of Markov chains with excel. Stationary distribution of a finite Markov Chain, continuous time Markov chain process. (Scope as in Chapter 1 of Ref [6]).

Unit IV

Queueing Models: Harbor system, morning rush hour, (Scope as in Ref [4]), structure of a queueing model, arrival process, service process and performance measures of a queueing systems, transient state and steady state. Probability distributions in queueing models. Poisson process, Pure death processes, birth and death process, Solution of single server model: M/M/1/FCFS, M/M/1/SIRO, M/M/1:N/FCFS, Solution of multi-server model: M/M/s/FCFS, M/M/s:N/FCFS. Finite population models, multiphase service model: M/Ek/1/FCFS, special purpose models, (Scope as in Ref [7])

Books Recommended

1. TynMyint-U and Lokenath Debnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.
2. Frank R. Giordano, Maurice D. Weir and William P. Fox, A First Course in Mathematical Modelling, Thomson Learning, London and New York, 2003.
3. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab,* 2nd Ed., Taylor and Francis group, London and New York, 2009.
4. S.L. Ross, *Differential Equations,*3rd Ed., John Wiley and Sons, India, 2004.
5. Mathematical Modelling, by J. N. Kapoor.
6. Markov Chains: Models, algorithms and applications. Wai-Ki Ching and Michael K. Ng, Springer, 2006.
7. Operation Research by B. S. Goel, S.K. Mittal, and Sudhir K. Pundir
8. TynMyint-U, Partial Differential equations of Mathematical Physics.